Gravimetric Soil Moisture Protocol

Purpose

To measure the water content of the soil

Overview

Soil moisture samples are collected following one of three sampling strategies. In each case, there are three basic steps:

1. collecting soil samples
2. weighing, drying, and reweighing soil samples
3. data submission

Time

Up to 15 minutes to collect each sample, 15 minutes for first weighing, 15 minutes for second weighing, samples dry in oven overnight

Frequency

Twelve times per year, at regular intervals (weekly to monthly)

Level

All

Key Concepts

Soil holds moisture.

Soil moisture increases after precipitation, and the amount of this increase depends on many factors.

Soil moisture decreases under dry, sunny conditions, and the rate of soil drying also depends on many factors.

Skills

Sampling soil

Using a balance

Recording data

Materials and Tools

GLOBE Science Notebooks and pencils

Soil Moisture Data Work Sheet (Star or Transect)

Trowel or appropriate auger

5-13 soil collection containers (soil sample cans, small glass jars with tight-fitting lids, etc.)

Adhesive tape and pens with which to label the soil cans

Soil drying oven

Thermometer (capable of measuring to 110° C)

Balance or scale with 0.1 g sensitivity

Hot pad or oven mitt for removing cans of soil from ovens

Meter stick

Preparation

Locate the soil moisture site.

Decide upon the sampling frequency and strategy.

Assemble the necessary materials.

Prerequisites

It is useful to have a rain gauge nearby and to have performed the *Soil Characterization Protocols* on your Soil Moisture Study Site.

How to Collect Soil Moisture Samples

Preparation for Collecting Samples

1. Review procedures, site sampling strategy, and layout.
2. Label each can with a unique identification number.
3. Record the location of the site and site description.
4. Locate the sampling point.

Procedures for Star and Transect Sampling

1. Note your surface cover type. Is it short grass (<10 cm), long grass, or bare soil? Scrape or pull this away. Note if there are any trees overhead or nearby.
2. Dig a hole 10 cm in diameter down to 5 cm. Leave this soil loose in your hole.
3. Sort out and remove any rocks or pebbles larger than a pea (about 5 mm) and remove any worms, grubs, or other animals.
4. Fill your soil collection container about 3/4 full with approximately 100 g of soil.
5. Number the container and record the date, time, depth and can number on your Soil Moisture Data Work Sheet.
   For Transect, skip to Step 9.
6. Remove the soil down to a depth of about 8 cm.
7. Dig the soil in the hole down an additional 4 cm leaving this soil in the hole.
8. Repeat steps 3, 4, and 5 for this 4 cm deep soil layer.
9. Carefully return remaining soil to the hole.
10. Seal the container and store away from heat or sunlight for transport back to the lab or classroom.
11. Take one soil temperature measurement within 25 cm of each soil sampling point at depths of 5 and 10 cm following the *Soil Temperature Protocol.*

Procedures for Depth Sampling

1. Take a sample of the top 5 cm of soil following Steps 1 - 5 as given for *Star and Transect Sampling.*
2. Auger a hole down to just above the first target depth (10 cm).
3. Use the auger to obtain a soil sample of approximately 100 g.
4. Collect the soil sample centered at the target depth.
5. Sort out and remove any rocks or pebbles larger than pea size (about 5 mm) and remove any worms, grubs, or other animals.
6. Fill a soil container about 3/4 full (about 100 g).
7. Number the container and record the date, time, depth and the container's number on your data sheet.
8. Seal the container tightly and store it away from heat or sunlight.
9. Repeat steps 1 - 8 at each depth (30, 60, 90 cm) using the same hole.
10. Carefully return the remaining soil into the hole.
11. Take three soil temperature measurements at depths of 5 cm and 10 cm within 25 cm of the sampling point.

How to Weigh and Dry the Samples

Preparation for Weighing and Drying Samples

1. Preheat the oven.
2. Calibrate the balance with a standard weight to ensure its accuracy.
3. Record the weight of the standard to the nearest 0.1 g in your GLOBE Science Notebook. The weight must be within 0.25 g of the previously recorded standard weight.

Weighing and Drying Procedure

1. Remove any tape from the can that contains the sample soil and uncover the sample.
2. Weigh the soil collection container with the soil sample in it. This is the *wet weight*.

3. Record the date and time at which the sample was collected, the container's number, and the wet weight to nearest 0.1 g on your Soil Moisture Data Work Sheet.
4. Dry the soil by placing the uncovered can in a drying oven using the following minimum conditions:
   Ventilated drying oven, 95° to 105° C, 10 hours,
   Dehydrating oven, 75° to 95 °C, 24 hours
   Microwave oven, high power, microwave safe container only, repeated 5 minute intervals until the sample(s) do not change in weight by 0.25 g from one drying to the next.
5. Remove the can from the oven with the hot pad or oven mitts. Let it cool for five minutes.
6. Re-weigh the soil collection container with the soil in it to obtain the *dry weight*.
   Note: If you are concerned that a sample is not totally dry, remove it from the oven, weigh it, and return it to the oven for 10 hours. If the weight does not decrease by 0.25 g, then it is dry.
7. Record the drying time, the type of drying oven used, and the dry weight to the nearest 0.1 g on your Soil Moisture Data Work Sheet. Calculate the water weight by subtracting the dry weight from the wet weight.
8. Empty the soil out of each container and wipe the can clean with a paper towel.
9. Weigh the dry, empty soil collection container to determine the container weight.
10. Record the container weight to the nearest 0.1 g on your Soil Moisture Data Work Sheet, and calculate the dry soil weight by subtracting the container weight from the dry weight.
11. Calculate the Soil Water Content by dividing the water weight by the dry soil weight, and record your result on the Soil Moisture Data Work Sheet.
12. Repeat steps 1 - 11 for each soil sample.

Data Submission

Report the following information to the GLOBE Student Data Server:

- Date and time of sampling
- Container number
- Depth (in cm)
- Wet weight (in grams)
- Dry weight (in grams)
- Container weight (empty, in grams)
- Drying method (select one of: 95-105 C oven, 75-95 C oven, Microwave)
- Average drying time (in hours and/or minutes)
- Current conditions: Is the soil saturated? (select either YES or NO)
- Station spacing of your transect, if used

Students can calculate the soil water content (SWC) defined below, or let the GLOBE Student Data Server make this calculation. Making this calculation and entering it on the Data Entry Sheet is helpful as a quality control check. If the SWC calculated by students is different by more than 1% from the value calculated by GLOBE, a warning message will appear. In this case, students should make sure that the weights were entered correctly and check their calculations.

In addition, please enter the following information using the Define a Soil Moisture Study Site Data Entry Sheet:

- GPS location of the study site (the center of the star, gypsum block hole, or reference marker at one end of the transect)
- Distances and directions to other related sites (rain gauge, max-min thermometer, closest soil characterization sample location)
- How would you describe the surface of your site? Select one: natural, plowed, graded, backfill soil, compacted soil, or something else (other)
- How would you characterize the surface cover? Select one, Primarily: bare soil, short grass (<10 cm), or long grass (>10 cm)

- How would you describe the canopy cover? Select one: Open, Some trees within 30 m or Canopy overhead (answer this question assuming growing season conditions)
- Soil classification (using the Soil Characterization Data Entry Sheet for these data)
  Describe and report as many soil characteristics as possible following the protocols in *Part One* of this investigation.
- Land Cover classification
  Classify your Soil Moisture Study Site as instructed in the *MUC System Protocol* and report the Level 4 MUC code and land cover name.